REMARKS

Claims 1-3 and 5-16 are amended. Claims 1-16 are pending in the application.

Claims 1-3 and 5-16 stand rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicant regards as the invention. Each of the numerous § 112 rejections set forth by the Examiner are based on a lack of antecedent basis. The Examiner set forth numerous suggestions on page 3, section 4 of the Action, as to appropriate correction of claims 1-3 and 5-16. Without admission as to the propriety of the Examiner's rejections, applicant has incorporated each of the changes suggested by the Examiner by amendment of claims 1-3 and 5-16. Accordingly, applicant respectfully requests withdrawal of the § 112 rejections of claims 1-3 and 5-16 in the Examiner's next action.

Claims 1-3 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Soleimani et al., U.S. Patent No. 5,596,218, and as being independently anticipated by Soleimani et al., U.S. Patent No. 5,330,920. In addition, claims 1-3 are rejected under 35 U.S.C. § 102(e) as being anticipated by Okuno et al., U.S. Patent No. 6,110,842, being anticipated by Shue et al., U.S. Patent No. 6,197,701, and being anticipated by Ghidini et al., U.S. Patent No. 6,114,203. The Examiner is reminded by direction to MPEP § 2131, that a proper anticipation rejection requires each and every element of a claim to be disclosed in a single prior art reference. Claims 1-3 are not anticipated by any of the cited references for at least the reason that each of the references cited fails to teach each and every element of any of those claims.

As amended, independent claim 1 recites forming a nitrogen-comprising layer across at least some of a silicon surface of a semiconductor substrate and, after forming the nitrogen-comprising layer, growing an oxide region having a thickness of at least about 70 angstroms and having the nitrogen of the nitrogen-comprising layer dispersed within the oxide region. The amendment to claim 1 is supported by the specification at, for example, page 7, line 20 through page 8, line 5; Fig 4; and page 10, line 23 through page 11, line 4. With respect to the Soleimani '218 patent, such discloses forming a layer of silicon dioxide over a substrate, and subsequently implanting nitrogen through the oxide layer and into the underlying substrate (col 3, lines 31-41 and col 4, lines 19-23). The '218 patent fails to disclose the recited forming a nitrogen-comprising layer across at least some of a silicon surface of a semiconductor substrate and subsequently growing an oxide region having a thickness of at least about 70 angstroms.

With respect to the Soleimani '920 patent, such discloses growing a sacrificial thermal oxide layer on a substrate and implanting nitrogen ions into the sacrificial oxide layer (col 2, lines 37-53). Soleimani '920 fails to disclose the recited forming a nitrogen-comprising layer across at least some of a silicon surface of a semiconductor substrate and subsequently growing an oxide region having a thickness of at least about 70 angstroms.

With respect to Okuno, such discloses nitridation of regions of a substrate and forming an oxide layer below the nitride layer (col 3, lines 55-56 and col 4, lines 11-15). Okuno fails to disclose the recited forming a nitrogen-comprising layer and subsequently growing an oxide region having a thickness of at least about 70 angstroms. With respect to Shue, such discloses forming a silicon layer over a

substrate and forming a silicon nitride containing layer on the silicon layer (col 5, lines 50-52 and col 6, lines 27-37). Shue fails to disclose the recited forming a nitrogen-comprising layer across a silicon surface of a substrate and subsequently growing an oxide region having a thickness of at least 70 angstroms.

With respect to Ghidini, such discloses forming a silicon dioxide layer 24 on a substrate (col 2, lines 56-61), removing the silicon dioxide layer from a section of the substrate, performing a nitriding treatment and subsequently oxidizing to reform an oxide layer (col 3, lines 3-7). Ghidini fails to teach the recited forming a nitrogen-comprising layer and subsequently forming an oxide region having a thickness of at least 70 angstroms. Accordingly, independent claim 1 is not anticipated by any of Soleimani '218, Soleimani '920, Okuno, Shue, or Ghidini and is allowable over these references. Additionally, each of Soleimani '218, Soleimani '920, Okuno, Shue, and Ghidini fails to suggest the claim 1 recited forming a nitrogen-comprising layer across at least some of a silicon surface of a substrate and subsequently forming an oxide region having a thickness of at least 70 angstroms. Independent claim 1 is therefore not rendered obvious by any of these references.

Dependent claims 2 and 3 are allowable over each of Soleimani '218, Soleimani '920, Okuno, Shue, and Ghidini for at least the reason that they depend from allowable base claim 1.

Dependent claims 4, 9, 10 and 11 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Okuno. Dependent claim 4 stands additionally rejected under 35 U.S.C. § 102(e) as being anticipated by Shue. Dependent claims 4, 9, 10 and 11 are

allowable over each of Okuno and Shue for at least the reason that the depend from allowable base claim 1.

Claims 12-14 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Ghidini. As amended, independent claim 12 recites forming a nitrogen-comprising layer across at least some of a first oxide region and across at least some of a semiconductor substrate that is not covered by the first oxide region. Claim 12 further recites after forming the nitrogen-comprising layer, growing a second oxide region from the at least some of the semiconductor substrate that is not covered by the first oxide region, the second oxide region having a thickness of at least about 70 angstroms. The amendment to claim 12 is supported by the specification at, for example, page 7, line 20 through page 8, line 5; Fig 4; and page 10, line 23 through page 11, line 4. Independent claim 12 is not anticipated by Ghidini for at least reasons similar to those discussed above with respect to independent claim 1. Further, Ghidini does not suggest the claim 12 recited second oxide region having a thickness of at least about 70 angstroms grown from the semiconductor substrate after forming a nitrogen-comprising layer and claim 12 is therefore not rendered obvious by this reference.

Claims 13-14 are allowable over Ghidini for at least the reason that they depend from allowable base claim 12.

Claims 1-16 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over various combinations of Okuno, Shue, Ghidini, DeBusk et al., U.S. Patent No. 6,140,187, and Hasegawa, U.S. Patent No. 6,091,109. A proper obviousness rejection requires some suggestion or motivation to modify or combine references, a reasonable expectation of success, and the references as combined must teach or suggest all of

the claim limitations (MPEP § 2143). Claims 1-16 are allowable over the various cited combinations of references for at least the reason that the references as combined fail to teach or suggest each and every feature in any of claims 1-16.

As discussed above with respect to independent claim 1, not one of Okuno, Shue, or Ghidini discloses or suggests the recited forming a nitrogen-comprising layer across at least some of a silicon surface and subsequently growing an oxide region having a thickness of at least about 70 angstroms. DeBusk discloses formation of a nitride layer during silicon deposition (col 3, lines 21-23) or immediately after gate oxidation (col 3, lines 56-59). DeBusk does not teach or suggest the recited forming a nitrogen-comprising layer across at least some of a silicon surface and subsequently growing an oxide region having a thickness of at least about 70 angstroms. As noted by the Examiner at page 11, section 13, Hasegawa does not teach or suggest the recited forming a nitrogen-comprising layer across at least some of a semiconductor substrate that is not covered by an oxide region. The various cited combinations of Okuno, Shue, Ghidini, DeBusk, and Hasegawa fail to disclose or suggest the claim 1 recited forming a nitrogen-comprising layer across at least some of a silicon surface and subsequently forming an oxide region having a thickness of at least about 70 angstroms. Independent claim 1 is therefore allowable over the various combinations of refernece s.

Dependent claims 2-11 are allowable as non-obvious over the various cited combinations of references for at least the reason that they depend from allowable base claim 1.

Independent claim 12 is allowable over the various cites combinations of Okuno, Shue, Ghidini, DeBusk and Hasegawa for at least reasons similar to those discussed

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above with respect to independent claim 1. Dependent claims 13-16 are allowable as non-obvious over the various cited combinations of references for at least the reason that they depend from allowable base claim 12.

For the reasons discussed above claims 1-16 are allowable. Accordingly, applicant respectfully requests formal allowance of claims 1-16 in the Examiner's next action.

Respectfully submitted,

Dated: 2-26-2002

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Appl. No. 09/602,395

Application Serial No. 09/602,395
Filing Date .... June 22, 2000
Inventor .... John T. Moore
Assignee .... Micron Technology, Inc.
Group Art Unit 2813
Examiner .... Pham, T.
Attorney's Docket No. MI22-1384
Title: Methods of Forming Oxide Regions Over Semiconductor Substrates

VERSION WITH MARKINGS TO SHOW CHANGES MADE ACCOMPANYING

RESPONSE TO DECEMBER 6, 2001 OFFICE ACTION

In the Claims

The claims have been amended as follows. Underlines indicate insertions and ~~strikeouts~~ indicate deletions.

1. (Amended) A method of forming an oxide region over a semiconductor substrate, comprising:

forming a ~~nitrogen-containing~~ nitrogen-comprising layer across at least some of a silicon surface of the semiconductor substrate; and

after forming the ~~nitrogen-containing~~ nitrogen-comprising layer, growing an oxide region from the at least some of the semiconductor substrate, the oxide region having a thickness of at least about 70 angstroms, the nitrogen of the ~~nitrogen-containing~~ nitrogen-comprising layer being dispersed within the oxide region.

2. (Amended) The method of claim 1 wherein the ~~substrate comprises silicon and the~~ oxide region comprises silicon dioxide.

3. (Amended) The method of claim 1 wherein the semiconductor substrate comprises monocrystalline silicon and the oxide region is grown from the monocrystalline silicon and comprises silicon dioxide.

4. The method of claim 1 wherein the nitrogen-comprising layer is formed from plasma activated nitrogen species.

5. (Amended) The method of claim 1 wherein the nitrogen-comprising layer is formed by remote plasma nitridation utilizing nitrogen species generated in a plasma that is at least about 12 inches from the semiconductor substrate.

6. (Amended) The method of claim 1 wherein the nitrogen-comprising layer is formed by remote plasma nitridation utilizing nitrogen species generated in a plasma that is at least about 12 inches from the semiconductor substrate; and wherein the semiconductor substrate not being biased relative to the plasma during formation of the nitrogen-comprising layer.

7. (Amended) The method of claim 6 wherein the semiconductor substrate is maintained at a temperature of from about 550 °C to about 1000 °C during formation of the nitrogen-comprising layer.

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8. (Amended) The method of claim 6 wherein the <u>semiconductor</u> substrate is exposed to the nitrogen species for a time of from greater than 0 minutes to about about 5 minutes.

9. (Amended) The method of claim 1 wherein the nitrogen-comprising layer is formed by plasma nitridation utilizing nitrogen species generated in a plasma that is at least about 4 inches from the <u>semiconductor</u> substrate.

10. (Amended) The method of claim 9 wherein the <u>semiconductor</u> substrate is maintained at a temperature of from about 0 °C to about 400 °C during formation of the nitrogen-comprising layer.

11. (Amended) The method of claim 9 wherein the <u>semiconductor</u> substrate is exposed to the nitrogen species for a time of from greater than 0 seconds to about about 30 seconds.

12. (Amended) A method of forming a pair of oxide regions over a semiconductor substrate, comprising:

forming a first oxide region which covers only a portion of the semiconductor substrate;

forming a nitrogen-comprising layer across at least some of the first oxide region and across at least some of the semiconductor substrate that is not covered by the first oxide region; and

after forming the nitrogen-comprising layer, growing a second oxide region from the at least some of the semiconductor substrate that is not covered by the first oxide region, the second oxide region having a thickness of at least about 70 angstroms.

13. (Amended) The method of claim 12 wherein the first oxide region is formed by:

forming an oxide layer over the covered region and at least some of the uncovered region of the semiconductor substrate; and

removing the oxide layer from over the uncovered region of the semiconductor substrate.

14. (Amended) The method of claim 13 wherein the oxide layer is formed by exposing the semiconductor substrate to oxidizing conditions.

15. (Amended) The method of claim 12 wherein the nitrogen-comprising layer is formed by remote plasma nitridation utilizing nitrogen species generated in a plasma that is at least about 12 inches from the semiconductor substrate.

16. (Amended) The method of claim 12 wherein the nitrogen-comprising layer is formed by plasma nitridation utilizing nitrogen species generated in a plasma that is at least about 4 inches from the semiconductor substrate.

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